

Appl. No.: 10/038,957
Amendment dated October 4, 2004
Reply to Office Action of June 2, 2004

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently amended) A method of making a composite three-dimensional object comprising:

(a) forming a continuous filament comprising a longitudinally extending continuous fiber and a material-laden composition comprising a thermoplastic polymer and at least about 40 volume % of a ceramic or metallic particulate, wherein the filament includes a green matrix material from the material-laden composition, and wherein the green matrix material completely surrounds the fiber;

(b) passing the filament to a movable assembly for guiding placement of the filament onto an associated working surface;

(c) depositing the filament from the movable assembly without application of a compression force onto the working surface to form a first lower filament layer having a predetermined filament orientation;

(d) depositing the filament from the movable assembly without application of a compression force onto the working surface to form a ~~second~~ an upper filament layer on top of the first lower filament layer;

(e) heating the ~~deposited~~ filament after it is deposited in the upper filament layer, a portion of the ~~second~~ upper filament layer adjacent the deposited filament and a portion of ~~first~~ the filament layer below and proximate to the deposited filament to a predetermined temperature effective for softening the green matrix material to provide a heated portion of deposited filament and filament layers;

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(f) compressing the heated portion with a force effective for consolidating and bonding the green matrix material of the deposited filament and filament layers; [[and]

(g) solidifying the heated portion;

(h) repeating steps (d) – (g) one or more times as desired to provide a composite object comprising two or more filament layers and having [[of]] a predetermined geometry.

2. (Original) The method of claim 1 further comprising preheating the filament as it is deposited onto the work surface to a temperature effective for adhering the filament to previously deposited filament.

3. (Original) The method of claim 1 wherein the filament includes one or more interface layers between the matrix material and the fiber for enhancing non-brittle failure characteristics of the composite and oxidation protection.

4. (Previously presented) The method of claim 3 wherein the one or more interface layer include materials selected from the group consisting of graphite, boron nitride, silicon carbide, boron carbide, silicon nitride and blends thereof.

5. (Original) The method of claim 1 wherein the filament includes a plurality of discrete fibers.

6. (Original) The method of claim 1 further comprising immersing the filament in a composition effective for increasing flexibility of the filament prior to depositing the filament onto the working surface.

7. (Original) The method of claim 1 further comprising:

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(a) creating a drawing of the desired composite three-dimensional object utilizing a computer-aided design process, wherein the process generates a drawing including a plurality of segments; and

(b) generating input signals based on the drawing for directing the movable assembly in the depositing the filament onto the working surface, wherein the movable assembly is guided in response to the signals.

8. (Original) The method of claim 1 further comprising blending a thermoplastic binder with the material-laden composition and heating the composite object to remove thermoplastic binder from the composite object and consolidating the composite object to provide a fully dense fiber reinforced composite object.

9-11. (Canceled)

12. (Previously Presented) The method of claim 1, wherein the composite object is heated to a temperature and for a time effective for sintering the green material.

13. (Previously Presented) The method of claim 1, wherein the filament is cut after a length of filament has been deposited on the working surface.

14. (Previously Presented) The method of claim 1, wherein the compression force is applied using one or more rollers.

15. (Previously Presented) The method of claim 1, wherein the heated portion is compressed with a force of about 190 newtons.

16. (New) A method of making a composite three-dimensional object comprising:

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(a) forming a feed rod having a longitudinal axis and having a hole extending down the longitudinal axis, the feed rod comprising a material-laden polymer composition comprising a thermoplastic polymer and at least about 40 volume % of a ceramic or metallic particulate;

(b) inserting an end of one or more fibers through the hole in the feed rod;

(c) extruding the feed rod and one or more fibers simultaneously to form a continuous filament that includes a green matrix material from the material-laden composition, the filament having an average diameter that is less than the average diameter of the feed rod and the green matrix material completely surrounding the fiber;

(d) passing the filament to a movable assembly for guiding placement of the filament onto an associated working surface;

(e) depositing the filament from the movable assembly without application of a compression force onto the working surface to form a lower filament layer having a predetermined filament orientation;

(f) depositing the filament from the movable assembly without application of a compression force onto the working surface to form an upper filament layer on top of the lower filament layer;

(g) heating the filament after it is deposited in the upper filament layer, a portion of the upper filament layer adjacent the deposited filament and a portion of the filament layer below and proximate to the deposited filament to a predetermined temperature effective for softening the green matrix material to provide a heated portion of deposited filament and filament layers;

(h) compressing the heated portion with a force effective for consolidating and bonding the green matrix material of the deposited filament and filament layers;

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(i) solidifying the heated portion;

(j) repeating steps (f) – (i) one or more times as desired to provide a composite object comprising two or more filament layers and having a predetermined geometry.